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Discussion* to IV. Light and Dark Adaption of the Photoreceptor Cell

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Since this session is on light and dark adaptation of the photoreceptor cells I would like briefly to draw attention to two studies related to this topic but not on the agenda.

This study concerns bacterial chemotaxis, a sensory phenomenon characterized by response to changes in the concentration of a variety of compounds. As in other sensory systems, a stimulus produces a change in behavior. The change is transient, since the response eventually disappears even though the concentration of the stimulatory compound remains at the new level, i.e. the organism adapts to the new level. It turns out that L-methionine is required by E. coli for adaptation to *increases* in attractant concentration but is not required for the *maintenance* of the adapted state or for the process of *deadaptation* that occurs when the concentration of attractant is lowered. The authors suggest that a methylation reaction, previously shown to be involved in chemotaxis, underlies these phenomena [1].

The Phycomyces sporangiophore is a single cell and responds phototropically, adapting to various light levels over a range of intensities of 10^9. The authors have analyzed the kinetics of this adaptation, using a tracking machine for greater precision. *Dark* adaptation is exponential with a time constant of 6 min, i.e. the threshold falls exponentially in the dark, in *contrast to scotopic vision* where the *logarithm of threshold* falls exponentially. The time constant is independent of temperature between 18 and 25° C. Dark adaptation after exposure to intensities sufficiently high to affect a large fraction of the receptor pigment is more complex. *Light* adaptation differs strikingly from dark adaptation. It overshoots and has faster kinetics [2].

I would like to draw attention also to a recent (published) paper showing that the "blue-light receptor" of Phycomyces is riboflavin [M. Delbrück, A. Katzir, and D. Presti (1976): "Responses of Phycomyces indicating optical excitation of the lowest triplet state of riboflavin". Proc. nat. Acad. Sci. (Wash.) **78,** 1969–1973].

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This photoreceptor molecule is *the* visual pigment in plants, fungi and bacteria. Phytochrome is limited to higher plants.

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Light-Activated Phosphorylation of Rhodopsin

Dr. Kühn has reported that about 6–10 phosphates are incorporated per photon absorbed when small percentages of frog rhodopsin are bleached, but that only four phosphates are incorporated per photon absorbed after larger bleaches. Dr. Kühn has also found that the extent of light-activated phosphorylation decreases if a bleached sample is left in the dark before ATP is added. The factors that determine the extent of light-activated phosphorylation of rhodopsin in the rod outer segment memrane may be physiologically important, particularly if rhodopsin phosphorylation has an effect on visual sensitivity; therefore, we have continued experiments to determine the maximum phosphate incorporation in bullfrog rhodopsin [1].

In agreement with results published previously [2], we find that a quantum flux which reduces the total rhodopsin concentration of outer segment membranes by less than 0.2% can trigger the incorporation of about 40 phosphates per photon absorbed. Thus, bleaching of a single rhodopsin molecule might also induce the phosphorylation of unbleached rhodopsin molecules. Light which bleaches more than 10% of the rhodopsin present is about ten times less effective in inducing phosphorylation. The mechanism of an amplification of photon absorption could be co-operative interactions between a photoproduct of rhodopsin and unbleached rhodopsin, or the activation of a soluble co-factor or enzyme which acts on unbleached rhodopsin.

We also have observed that the effectiveness of light in triggering phosphorylation is reduced if a time lapse is introduced between the illumination and the addition of ATP which starts the phosphorylation. This time-dependent decrease in phosphorylation activation occurs in both isolated retinas and in membranes depleted of enzyme activities. This dark process is independent of concomitant reactions of the rhodopsin chromophore. In partially bleached membranes the phosphorylation reaction can be reactivated by further illumination. If all of the rhodopsin is bleached, the system can be reset for phosphorylation by the regeneration of rhodopsin. We assume that the reversal of light-activation is one of the processes which control rhodopsin phosphorylation in vivo.

References

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2. Bownds, M. D., Brodie, A., Robinson, W. E. , Palmer, D., Miller, J. A., Shedlovsky, A.: Physiology and enzymology of frog photoreceptor membranes. Exp. Eye Res. **18**, 253–269 (1974)